REMARKS

Claims 19-51 are pending in the Application.

Claims 19-51 stand rejected.

I. REJECTIONS UNDER 35 U.S.C. § 103(a) OVER *HAMWI*

The Examiner has rejected Claims 19-51 under 35 U.S.C. § 103(a) as being unpatentable over *Hamwi et al.*, "Fluorination of Carbon Nanotubes," *Carbon*, **35**(6), 723-728 (1997) ("*Hamwi*"). Paper No. 6, at 2. Applicant respectfully traverses this rejection.

The Examiner contends that because "the claimed fluorinating agents are old and known as fluorinating agents, and the single walled nanotubes are old and known" and because "Hamwi teaches a wide range of temperatures and degrees of fluorination, and differs in not teaching SWNTs; only multi-walled tubes," that "it would have been obvious to one of ordinary skill in the art at the time the invention was made to use SWNTs in the process of Hamwi because doing so makes a treated carbon nanotube, for catalytic or chemical purposes." Paper No. 6, at 2.

However, to establish a *prima facie* case of obviousness, at least three basic criteria must be met. First, there must be some suggestion or motivation, either in the reference itself or in the knowledge generally available to one of ordinary skill in the art, to modify the reference. Second, there must be a reasonable expectation of success. Finally, the prior art reference must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art and not based on Applicant's disclosure. *In re Vaeck,* 947 F.2d 488, 20 U.S.P.Q.2d 1438 (Fed. Cir. 1991); *see also* M.P.E.P §§ 2143-2143.03.

For each of the pending claims, these three basic criteria are not met. Thus, no *prima facie* case of obviousness has been established.

Claims 19-51. Claim 19, and Claims 20-25 which depend from it, are directed towards a method of derivatizing single-wall carbon nanotube sidewalls. Claims 26-51 all require single-wall carbon nanotubes that have fluorine bonded to the sidewalls of the nanotubes.

1. *Hamwi* provides no suggestion or motivation to use its processes on single-wall carbon nanotubes

The carbon nanotubes of *Hamwi* are, as the Examiner points out (Paper No. 6, at 2), multi-

wall carbon nanotubes having diameters from 20-40 nm (p. 724, col. 1, para. 3). Claims 19-51 each require single-wall carbon nanotubes, which are almost always less than 3.5 nm in diameter. The distinction between single-wall and multi-wall carbon nanotubes is important because multi-wall carbon nanotubes are fundamentally different from single-wall carbon nanotubes.

Single-wall carbon nanotubes have only a single layer of sp^2-hybidized carbon atoms generally arranged in a hexagons and pentagons. Because of their single-layer, SWNT generally cannot support defects in growth and are more susceptible to destruction by bond breakage or reaction. In contrast, multi-wall carbon nanotubes are composed of multiple, cylindrical concentric carbon layers arranged in a nested fashion (analogous to Russian "nesting dolls"). Because of this arrangement, the carbon shells of multi-wall carbon nanotubes can withstand wall defects, which often appear as dislocations, kinks, holes, edges on the side-wall surfaces, *etc.* Also because of their multiple layers and the interconnections between these layers, multi-wall nanotubes can withstand much more rigorous chemical processing, physical conditions, and extensive chemical bond breakage without nanotube destruction compared to single-wall carbon nanotubes.

Single-wall carbon nanotubes "rope" together and are held tightly by van der Waals forces. As such, single-wall nanotubes are difficult to separate and disperse in other media, while multi-wall nanotubes do not rope and, as such, are readily separable and dispersable. The structural differences between single-wall and multi-wall carbon nanotubes also leads to differences in physical and chemical properties, such as tensile strength, modulus, flexibility, thermal conductivity, electrical conductivity, chemical reactivity and chemical stability.

As a result of such differences, the chemistry that can be done with each species is quite different and would be unpredictable. Thus, it would not have been obvious to one of ordinary skill in the art to apply the processes of *Hamwi* to the fluorination of single-wall carbon nanotubes.

2. There is no reasonable expectation of success that the processes of *Hamwi* would have derivatized single-wall carbon nanotubes

Furthermore, there is no reasonable expectation of success in using the *Hamwi* process on single-wall carbon nanotubes. *Hamwi* discloses fluorinating multi-wall carbon nanotubes under two fluorinating conditions: (1) with a mixture of F_2, IF_5, and HF at room temperature; and (2) with pure F_2 at about 500°C. *See Hamwi*, p. 726, col. 1 & p. 727, col. 2.

Since single-wall carbon nanotubes do not react significantly with fluorine at room

temperature[1] and they are destroyed by a reaction with fluorine at 500°C,[2] there is no expectation of success in producing fluorinated single-wall carbon nanotubes as claimed in the Application by applying the process described by *Hamwi* to single-wall carbon nanotubes.

3. *Hamwi* fails to teach all the claimed limitations of each of Claims 19-51

Additionally, there is no suggestion in *Hamwi* to carry out the disclosed processes on single-wall carbon nanotubes, which is required by each of Claims 19-51.

Furthermore, *Hamwi* likewise fails to teach other elements in the claims, such as the reaction temperatures within the ranges, as set forth in Claims 21-22, 30, 40, 41, and 49. *Hamwi* also fails to teach or suggest a method of controlling the level of fluorination, nor does *Hamwi* teach any relationship between the degree of fluorination and conductivity, both of which are required by Claim 33.

Thus, *Hamwi* simply does not teach or suggest all the claim limitations of each of the claims.

As discussed above, *Hamwi* provides no suggestion or motivation to use its processes on single-wall carbon nanotubes, there is no reasonable expectation of success that the processes of *Hamwi* would have derivatize single-wall carbon nanotubes, and *Hamwi* fails to teach all the claimed limitations of each of Claims 19-51. Consequently, none of the three basic criteria recited above for establishing a *prima facie* case of obviousness have been met in rejecting any of Claims 19-51. Accordingly, Applicant respectfully requests the Examiner withdraw the rejection of Claims 19-51 under 35 U.S.C. § 103(a) as being unpatentable over *Hamwi*.

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[1] *Hamwi* refers to the product of the room temperature reaction as a "intercalation compound." *Hamwi*, p. 728, col. 1.

[2] *Hamwi* disclosed the product of the 500°C temperature reaction as having a F/C ratio of 1, that the tubular structure disappeared during the process, and that the resulting product is amorphous fluorinated carbon. *Hamwi*, p. 726, col. 1 & p. 727, col. 1-2. That means this process did not yield a product that is a carbon nanotube. *Id.* This is consistent with the Application. *See, e.g.*, Application, at 18, *ll* 6-9.

CONCLUSION

As a result of the foregoing, it is asserted by Applicant that the Claims in the Application are in condition for allowance, and respectfully requests an early allowance of such Claims.

Applicant respectfully requests that the Examiner call Applicant's attorney at the below listed number if the Examiner believes that such a discussion would be helpful in resolving any remaining problems.

Respectfully submitted,

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